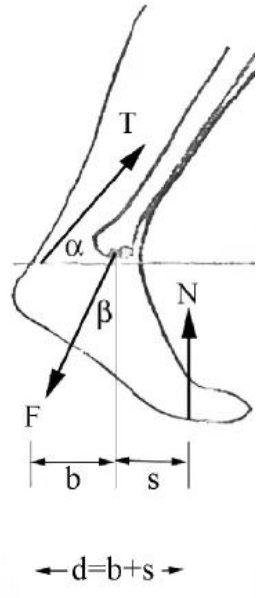
Answer on Question #48872-Physics-Other

A gymnast balances on the ball of a single foot, the normal force provided by the ball has to equal her weight. Her foot can be thought of as a single rod with the normal force at her tibia and achilles tendon supplying forces at the other end. If the gymnast has a weight (mass times gravity) of 425N, find the force the tendon must supply. There is 20cm from the ball of the foot to the tendon and 14 cm from the ball of the foot to the tibia, and the angle the tibia makes relative to vertical is 15 degrees.

Solution



$$N + T\sin\alpha - F\cos\beta = 0$$

$$T\cos\alpha - F\sin\beta = 0$$

$$T\sin\alpha \cdot d = F\cos\beta \cdot s.$$

From these equations:

$$F = T\frac{\cos\alpha}{\sin\beta}; T\sin\alpha \cdot d = T\frac{\cos\alpha}{\sin\beta}\cos\beta \cdot s \to \tan\alpha = \frac{s}{d}\cot\beta = \frac{14}{20}\cot 15 = 2.61 \to \alpha = 69°.$$

$$N + T\sin\alpha - T\frac{\cos\alpha}{\sin\beta}\cos\beta = 0.$$

Achilles tendon supplying force is

$$T = \frac{N}{\cot\beta\cos\alpha - \sin\alpha} = \frac{425\text{N}}{\cot 15\cos 69 - \sin 69} = 1052\ N.$$

Answer: 1052 N.